DOCUMENT RESUME

ED 089 749 IR 000 461

AUTHOR	Kuipers, J. W.; Thorpe, R. W.
TITLE	Study of Decision Factors in Planning DBPH Audio Services.
INSTITUTION	Library of Congress, Washington, D.C. Div. for the Blind and Physically Handicapped.; Q.E.I., Inc., Bedford, Mass.
REPORT NO	QEI-4131
PUB DATE	31 Jan 74
NOTE	88p.
AVAILABLE FROM	Library of Congress, Division for the Blind and Physically Handicapped, 1291 Taylor Street, N.W., Washington, D.C. 20542
EDRS PRICE	MF-$0.75 HC-$4.20 PLUS POSTAGE
DESCRIPTORS	*Audio Equipment; Blind; Educational Specifications; Equipment Evaluation; *Federal Programs; *Library Planning; Media Selection; Partially Sighted; Phonograph Records; *Physically Handicapped; Program Planning; Tape Recorders; Tape Recordings; Visually Handicapped
IDENTIFIERS	DBPH; *Division for the Blind and Physically Handicapped; Library of Congress

ABSTRACT

A study was made to aid in planning for future operations of the "listening services" for the Blind and Physically Handicapped (DBPH), Library of Congress. Available data was gathered and organized. DBPH operations were analyzed as were economic models and functional factors for decision-making regarding recording media and playback machines. The principal planning decisions were classified as system equipment costs and product quality factors. Equipment costs included system options as of 1976 as well as 1980 in order to show future trends in equipment costs. (Also, the unit costs for books and magazine media were projected as of 1976). The quality factors included machine breakdown rate, convenience, user acceptance, quality of sound, operational problems or risks, ease of duplication of media in the field, storage and shelving of media for libraries, wearing of media, and the possibility of reuse of media. A decision matrix was formulated which compared five alternative sound reproduction systems. The authors concluded that DBPH should adopt the 4-Track 15/16 ips C90 cassette format. Other recommendations and suggested items for follow-up are listed. (WCM)

ED 089749

STUDY OF DECISION FACTORS IN PLANNING DBPH AUDIO SERVICES

By

J. W. Kuipers and R. W. Thorpe

Q.E.I. Report 4131

Prepared for Division for the Blind and Physically Handicapped, Library of Congress, Washington, D.C.

January 31, 1974

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STUDY OF DECISION FACTORS IN PLANNING FUTURE DBPH AUDIO SERVICES

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STUDY OF DECISION FACTORS IN PLANNING FUTURE DBPH AUDIO SERVICES

A. INTRODUCTION

This report summarizes the results of a study made by Q.E.I., Incorporated for the Division for the Blind and Physically Handicapped, Library of Congress. The study addresses problems concerned with the planning for future operations of the audio or "listening services" of the DBPH. It develops and organizes available data, does analysis of DBPH operations and proposes certain models of economic and functional factors for the purpose of assisting the DBPH to make decisions regarding recording media and playback machines for its future operations.

The DBPH is responsible for administering a national program to provide reading materials on a free loan basis to blind and physically handicapped residents of the U.S.. For the year 1972 it circulated 9,110,000 volumes to about 322,000 blind and handicapped persons thrqugh 51 Regional Libraries. It acquired 1200 books and 45 magazines for national distribution and procurred 45,000 sound reproducers and distributed them through various agencies and libraries. The DBPH also cooperates with many volunteers who give a great deal of assistance in recording, copying and machine repair activities.

The DBPH is now in a period where demand for its services are being received at a rate which continues to increase each year. Requests for the loan of Talking Books and sound reproducers have increased by about 11% per year for the past several years.

Because of the increasing demand for services and the gradual incorporation of more eligible persons into the program, the DBPH is faced with a number of very important decisions about the nature of the services it shall continue to provide. Particularly, it must make decisions regarding the kind of media (records or cassettes) and the kind of sound reproduction equipment it will use in the program. The areas require decisions because developments in audio recording and reproduction in the past few years have made new options available which have direct effects on production costs as well as the convenience and acceptability to the user of the DBPH audio or "listening services".

This study was conducted over a six-week period and was focussed on the DBPH audio service area only. In this study effort all immediately available data was reviewed and researched. Contacts were made with representative portions of the user population of DBPH. A sampling of opinions was obtained from Regional Library centers as well as manufacturers and service organizations in the sound reproduction field. A list of the personal contacts as well as mail and telephone contacts made in this study is given in Appendix I.

B. MANAGEMENT PARAMETERS IN DBPH AUDIO-RELATED OPERATIONS

1. Enabling Legislation

The legislation, which set up the DBPH and which was first adopted in 1931 and later amended in 1966, specifies the kind of services which shall be provided for the blind and physically handicapped. The DBPH shall provide reading materials in the form of braille and sound recordings including sound reproducers. These shall be supplied to eligible users on a no charge loan basis and provision is made for free use of the mail service to carry out distribution.

2. Primary Objectives in Providing Listening Services

It is the prime objective of the DBPH management in carrying out the provisions of its charter to use its available funding to achieve services which will provide the greatest benefit to meet the needs of the larger portion of the eligible user population. The DBPH will not just send out library materials but will send such materials as will meet the needs of its users in matters of convenience and ease of use of the materials it distributes. It will strive for quality products at all times and for user acceptance of its services within the bounds of its charter and the funding which has been provided.

3. Minimization of Production Costs

In order to make the best possible use of available funding it is a policy of DBPH to take all possible steps to minimize production costs. It conducts tests, makes use of competitive bidding to achieve best results at lowest cost. It does make use of the services of other organizations who generate materials to assist

the blind and physically handicapped. To achieve lower costs it has for many years pressed for the use of minimal formats and equipment to achieve acceptable service products. It has achieved great success over a period of years in condensing recorded books to the most compact, but still fully usable and convenient package.

4. Volunteer Assistance

As the DBPH program evolved, regional distribution centers have been set up and state and local governments have given these increasing support. A very significant contribution is being made by volunteer groups who assist in delivery, recording, machine repair and other services. It is a policy of DBPH to count on continuing assistance from these groups in its future programs. It will want to continue its operations in the future in a way that will promote and encourage further assistance and support from this direction.

5. Application of New Technology

The DBPH has exploited many newly developed technologies in setting up its audio services. It will wish to continue to apply new methods, media, and equipment as these are tested and proven to be worthwhile. To make it possible to effect desirable changes as these may develop, a degree of flexibility has to be maintained in the DBPH operation.

6. Non-Competitive Services

In setting up the DBPH it was not intended that DBPH services become the serious competitor of any on-going commercial activity. It has been a policy too that DBPH will respect the interests of the copyright owners of books and library materials. Thus far there

has been little difficulty in obtaining approvals from copyright owners to use their materials for DBPH services. If the formats used by DBPH become widely used commercially, or if a very much larger population is to be served by DBPH, copyrights may become a more significant factor.

7. Narrow Range of Management Options

A study of the various factors which DBPH management must take into consideration in its planning makes it very apparent the options for choice and decision are very limited. The DBPH has built up services over a period of years which are serving a large user group. The people served are very dependent on these services. It will not be possible to make changes which will affect the present quality of existing services or degrade the convenience level which is now in effect. Whatever changes are made must be in the direction of improvements, increased coverage and service and these, hopefully, at lower unit costs.

8. Immediate Problems

The DBPH is confronted with increasing numbers of requests for listening materials and equipment. In order to minimize costs it has opportunities to change its media so that a more condensed format can be used. It also has decisions to make in connection with the use of cassette players which have found very high user acceptance. It is the purpose of this study to examine the various factors which DBPH will need to take into account in arriving at decisions on these matters. Sections C and D of this report summarize the projections into the future, of user requirements, and give production levels and costs to the year 1980 for the present

mix of listening media and equipment. Sections E thru I review alternatives and options with supporting data, and Section J is a summary of recommendations. Table I gives a summary of the various media under consideration in this report and the various playing times for audio formats which are under discussion.

TABLE I

PLAYING TIMES FOR DIFFERENT MEDIA

Playing Time (Minutes) per Record (Both Sides)

Records	16 2/3 rpm	8 1/3 rpm
10-inch Records (Hard)	88 min.	176 min.
9-inch Records (Flexible)	58 min. Average	150 min. Possible 116 min. Average

Playing Times per Cassette

Cassettes	1 7/8 ips 2-Track	1 7/8 ips 4-Track	15/16 ips 2-Track	15/16 ips 4-Track	15/32 ips 2-Track	15/32 ips 4-Track
C-60	60 min.	2 hrs.	2 hrs.	4 hrs.	4 hrs.	8 hrs.
C-90	90 min.	3 hrs.	3 hrs.	6 hrs.	6 hrs.	12 hrs.
C-120	2 hrs.	4 hrs.	4 hrs.	8 hrs.	8 hrs.	16 hrs.
C-30	30 min.	60 min.	60 min.	2 hrs.	2 hrs.	4 hrs.

Note: rpm = revolutions per minute; ips = inches per second

C. REVIEW OF THE PROBABLE DEMAND FOR DBPH AUDIO SERVICES

1. Introduction

In normal economic situations the demand for a particular good or service is somehow related to the cost of that good or service. Usually as the cost of a good increases the demand for it decreases; and as the good's cost decreases the demand for it increases. This is not the situation faced by the Division for the Blind and Physically Handicapped (DBPH). It appears that demand for goods or services provided by the DBPH is basically unrelated to their cost. This is so because the consumers of DBPH good and services do not have to pay for them. They are provided free of all charge to the consumers by the DBPH.

It could be argued that in contrast to the usual economic situation, the demand for DBPH goods and services would increase as their costs increase. This might happen because persons eligible to receive DBPH goods and services might have preferred to purchase their own goods from private sources while the price of these goods was still low; but once the price of these goods rose, they might be forced to obtain DBPH goods. However, the above does not seem to be a particularly important consideration, since the number of persons eligible for DBPH goods who purchase similar goods from private sources appears to be rather small. (The number of persons eligible for DBPH goods who use their own cassette players exclusively is estimated by the DBPH statistician at 1,250). For this reason and to keep the analysis tractable, it has been decided to assume that demand for and cost of any DBPH goods and services are unrelated. Thus, it is reasonable to formulate separate demand and cost

models for the different DBPH goods and services.

It will also be assumed that DBPH goods and services face no competition. It is assumed that since they are provided free to eligible consumers that no other institution or group will be able to provide equivalent goods or services at a competitive price, nearly zero. This is not of course strictly true, since some people do purchase equivalent goods and services from private sources. However, since these private purchases appear to be small in number, it will be assumed that the provision of DBPH goods and services is non-competitive.

In addition, no consideration will be given to the possibility of immediate satisfaction of all potential demand or saturation of the market, since the number of potential consumers of DBPH goods and services who presently are certainly eligible for those goods appears to exceed the number of present consumers by a factor of at least four. Thus, it appears that for the foreseeable future DBPH need have no concern that new requests for their goods and services originate from a rapidly diminishing market. DBPH can assume that requests for their goods and services can continue in the immediate future to rise as before.

The demand (or market) model will consist principally of year-by-year estimates of the market for DBPH audio services from 1971-1980. These year-by-year estimates of demand will consist of 1) the number of potential users, 2) the expected number of users served, 3) the expected number of users served if the DBPH runs a promotional campaign, 4) the number of recorded items (book, magazines) required to meet the demands of the expected number of users, 5) the number

of machines in the field needed to meet this demand assuming the present media and machine mix, and 6) the number of machines needed to meet demand assuming the projected media and machine mix.

2. Projections of Potential Usage

Potential users of DBPH audio services will be divided into two mutually-exclusive classes: users who are certainly eligible for DBPH goods and services and users who are possible eligible for DBPH goods and services. This seems like a reasonable and important division of the group of potential users, since it would appear to be most essential to ascertain how many people are certainly eligible for DBPH goods and services, but are not using them. This division has already been established by DBPH for their eligibility statistics(1). (See Appendix II for the summary of DBPH Eligibility Statistics.).

It was decided to predict the number of potential users of DBPH services who are certainly eligible for them by doing a linear projection on numbers of potential users with certain eligibility from data available for some years preceding 1974. The number of potential users for a particular year who are certainly eligible for DBPH goods and services, according to DBPH, is composed of two groups: those with severe visual impairments and those who are physically disabled - those afflicted by absence of one or both arms or hands, cerebral palsy (paralyzed), muscular dystrophy (completely disabled), quadriplegia, and hemiplegia. However, it seems likely that some of those listed as having severe visual impairments are also listed as physically disabled so, to avoid double counting the number of physically disabled is reduced by a certain percentage (¼ the percentage from the Nelson report(2)) representing those persons who are

physically disabled and also have severe visual impairments. Also, persons who are deaf or suffer from severe hearing impairments would be unable to use DBPH audio goods and services. But, both the statistics for those with severe visual impairments and for the physically handicapped include some persons who are also partially deaf. Thus, the number of those afflicted with severe visual impairments and the reduced number of physically handicapped must both be reduced by certain percentages ($\frac{1}{2}$ the percentage from the Nelson report(2)) to eliminate persons who are also partially deaf and thus unable to use DBPH audio goods and services.

The seven estimates for the years 1974 through 1980 of the numbers of potential users of DBPH goods and services who are certainly eligible are presented in Table II, Col. 1. Those estimates were derived by linear projection using estimates of potential users of certain eligibility for 1965 (3) and 1971 (1) and U.S. population projections.

To predict the number of potential users of DBPH goods and services who are possibly eligible for them, a linear projection was done on numbers of potential users with possible eligibility from data available for some years preceding 1974. Potential users with possible eligibility for DBPH services consist, according to the DBPH (1), of those afflicted with arthritis or rhemuatism, cerebral palsy (excluding those paralyzed), Huntington's disease, muscular dystrophy (excluding those completely disabled), myasthenia gravis, paraplegia, Parkingson's disease, spina bifida, spinal cord injury and tumors of the brain and nervous system. However, it has been decided to eliminate from this list those with learning disabilities.

TABLE II

EXPECTED NUMBER OF POTENTIAL USERS OF

DBPH AUDIO SERVICES

Year	Potential Users of Certain Eligibility	Potential Users of Possible Eligibility	All Potential Users
1974	1,834,000	4,175,000	6,009,000
1975	1,855,000	4,220,000	6,075,000
1976	1,876,000	4,264,000	6,140,000
1977	1,897,000	4,309,000	6,206,000
1978	1,918,000	4,354,000	6,272,000
1979	1,939,000	4,399,000	6,338,000
1980	1,961,000	4,444,000	6,405,000

Since eligibility requirements for those with learning disabilities are currently under discussion; and to reduce the higher estimate of those afflicted with mental retardation by 75% since it is estimated by the President's Committee on Mental Retardation that only 25% of the mentally retarded have physical handicaps and are thus possibly legally eligible for DBPH assistance. (DBPH assistance is restricted by law to the blind and physically handicapped). The total from this reduced list must be further reduced by a certain percentage to eliminate those afflicted with severe visual impairments and physical handicaps, since such persons are included in the total of those who are certainly eligible for DBPH services; and must also be reduced by another percentage to avoid including persons who are partially deaf as well as physically handicapped and who would therefore be unable to use DBPH audio services. (The percentages used to reduce the totals are ¼ and ½ respectively of the percentages from the Nelson report (2)).

The seven estimates for the years 1974 through 1980 of the number of potential users of DBPH goods and services who are possibly eligible are presented in Table II, Col. 2.. These estimates were derived by linear projection using estimates of potential users of possible eligibility for 1965 (3) and 1971 (1) and U.S. population projections.

3. Projections of Actual Usage

To obtain the required year-by-year estimates of the expected number of users served by the DBPH audio services for the period from 1974 to 1980, it was decided to divide the users into two mutually-exclusive classes: individual readers of Talking Books or

Cassette Books and readers served by deposit collections. This division was made since the estimates of readers served by deposit collections certainly contain larger errors than the counts of individual readers due to the fact that the number of readers served by a particular deposit collection is often unknown and must be estimated by an average. Thus, it was decided to predict the expected number of individual readers and the number of readers served by deposit collections by doing two separate linear regressions on data available on numbers of readers in past years. (See Appendix III for a discussion of linear regression.). Linear regression analysis is considered adequate in this instance since as mentioned before the market for DBPH audio services is nowhere near saturation.

The seven estimates for the years 1974 through 1980 of the expected number of users served by DBPH audio services are presented in Table III along with estimates of the standard error of prediction in each. Those estimates were derived by two separate linear regression analyses on the number of individual readers of Talking Books and Cassette Books and on estimates of the number of readers served by deposit collections for the 6 and 4 years preceding 1974, respectively. (Estimates of individual readers for the years preceding 1974 include open reel tape users who numbered 10,000 on the average.).

In addition, seven estimates for the years 1974 through 1980 of the expected number of individual users served by DBPH audio services, assuming that a promotional campaign is launched which increases by 10% the rates of readership growth, are presented in Table IV along with estimates of the standard error of prediction in each.

To obtain the required year-by-year estimates of the numbers of

TABLE III

EXPECTED NUMBER OF USERS SERVED BY DBPH AUDIO SERVICES

Year	Expected Number of Individual Users Served	Standard Error of Prediction of Col. 2 (90% Confidence Level)*	Expected Number of Users in Deposit Collections Served	Standard Error of Prediction of Col. 4 (90% Confidence Level)	Expected Total Number of Users Served by DBPH
1974	258,000	±37,000	140,000	± 47,000	398,000
1975	282,000	±42,000	165,000	± 58,000	447,000
1976	306,000	±47,000	190,000	± 69,000	496,000
1977	330,000	±52,000	215,000	± 81,000	545,000
1978	354,000	±57,000	240,000	± 93,000	594,000
1979	378,000	±63,000	265,000	±105,000	643,000
1980	402,000	±69,000	290,000	±118,000	692,000

*See Appendix III

TABLE IV

EXPECTED NUMBER OF INDIVIDUAL USERS SERVED BY DBPH AUDIO SERVICES ASSUMING A PROMOTIONAL CAMPAIGN

Year	Expected Number of Users Served	Standard Error of Prediction (90% Confidence Level)
1974	275,000	±37,000
1975	302,000	±42,000
1976	328,000	±47,000
1977	354,000	±52,000
1978	381,000	±57,000
1979	407,000	±63,000
1980	433,000	±69,000

recorded items (books, magazines) required to meet the demands of the expected number of Talking Book users, it was decided to assume that the trend continues and thus the number of copies of Talking Books will rise in proportion to the number of Talking Book readers. Talking Book record readers are either individual readers or readers served by deposit collections. The expected numbers of individual Talking Book record readers for the seven years from 1974 to 1980 were estimated from a linear regression done on the number of individual Talking Book record readers for the 6 years preceding 1974 with adjustments made for the rising popularity of cassette systems among DBPH users. It is assumed that during the period from 1974-1976 the rate of increase of Talking Book record users will be 10% less than the rate that pertained before 1974; and that from 1976 on the rate of increase of Talking Book record users will be 20% less than the rate before 1974. Such decreases in the rate of increase of Talking Book users are considered to reflect a shift from Talking Book record systems to cassette systems that is consistent with the rates at which cassette systems are presently being supplied and overall demand is increasing. These predictions are presented in Table V, Col. 1 and 2. The number of readers of Talking Book records from deposit collections is then predicted from a linear regression on the past numbers of readers of deposit collection books multiplied by the ratio of Talking Book machines to total number of machines in deposit collections for the 4 years preceding 1974. (It is assumed that at present the ratio of Talking Book machines to total number of machines in deposit collections is around .9 This estimate was derived from figures from DBPH on the circulation

TABLE V

EXPECTED NUMBERS OF COPIES OF TALKING BOOKS ON HARD RECORDS AND MAGAZINES (FLEXIBLE DISCS) REQUIRED TO MEET THE NEEDS OF DBPH USERS*

Year	Expected Number of Individual Talking Book Record Readers	Standard Error of Prediction of Col. 2 (90% Confidence Level)	Expected Number of Deposit Collection Talking Book Record Readers	Standard Error of Prediction of Col. 4 (90% Confidence Level)	Expected Number of Copies of All Talking Books on Records	Expected Number of Copies of All Magazines
1974	200,000	±25,000	126,000	±42,000	480,000	2,680,000
1975	215,000	±28,000	144,000	±51,000	528,000	2,930,000
1976	228,000	±31,000	161,000	±59,000	572,000	3,180,000
1977	241,000	±34,000	177,000	±67,000	614,000	3,430,000
1978	254,000	±38,000	192,000	±74,000	655,000	3,680,000
1979	267,000	±42,000	205,000	±81,000	694,000	3,930,000
1980	280,000	±46,000	217,000	±88,000	731,000	4,180,000

*Projections Based on Present Service Ratios with Adjustments Included for Present Trends.

of Talking Book records and Cassette Books in deposit collections, assuming that estimates of past average circulation per reader are applicable to deposit collection readers. It is of course true that there are some states or regions (Iowa, Minnesota, Nebraska) where this ratio seems to be much lower (.5 - .75); but these are certainly offset by states or regions where as of 1972 there existed large numbers of Talking Book machines in deposit collections, but no cassette players. Such states or regions include Northern New York, Georgia, Wisconsin, and Southern New York. However, regional librarians have indicated a desire to increase the number of cassette players in deposit collections to facilitate the use of DBPH audio service by ill people; so that it has been assumed that the ratio of Talking Book Machines to total number of machines in deposit collections will decrease by .025 per year up to 1980. Such a small increase seems reasonable in view of the great demand for cassette players by individual readers.). These predictions are given in Table V, Col. 3 and 4. The expected number of individual readers of Talking Book records is added to the expected number of readers of Talking Book records in deposit collections for the years 1974 to 1980. The ratios of these expected future numbers of Talking Book readers to the present number of Talking Book readers are then multiplied by the total number of copies of Talking Books on records predicted by DBPH for 1974 to give the number of copies of Talking Books on records required for each of the years from 1974 to 1980. The number of copies of magazines required for each of the years from 1974 to 1980 is then predicted by assuming that magazine circulation will rise in proportion to growth in total readership, using the 1973

magazine circulation of 2,581,900 as the starting point. These predictions are presented in Table V, Col. 5 and 6.

Once more the number of copies of Cassette Books is assumed to rise in proportion to the number of Cassette Book readers. Then, the expected numbers of individual Cassette Book readers for the six years from 1975 to 1980 were estimated from a linear regression done on the number of individual Cassette Book readers for the 6 year preceding 1975. These predictions are presented in Table VI, Col. 1 and 2. The number of readers of Cassette Books from deposit collections is then predicted from a linear regression on the past numbers of readers of deposit collection books multiplied by the ratio of cassette machines to the total number of machines in deposit collections for the 4 years preceding 1974. (As discussed above, it is assumed that at present the ratio of cassette players to total numbers of machines in deposit collections is around .1; further, it is assumed that this ratio will increase by .025 per year up to 1980.). These predictions are given in Table VI, Col. 3 and 4. The expected numbers of individual readers of Cassette Books are added to the expected numbers of readers of Cassette Books in deposit collections for the years 1974 to 1980. The ratios of these expected future numbers of Cassette Book readers to the present numbers of Cassette Book readers are then multiplied by the present total numbers of copies of Cassette Books to give the number of copies of Cassette Books required for each of the years from 1974 to 1980. These predictions are presented in Table VI, Col. 5.

To obtain the required year-by-year estimates of the numbers of Talking Book record machines and cassette players in the field to

TABLE VI

EXPECTED NUMBERS OF COPIES OF CASSETTE BOOKS REQUIRED TO MEET THE NEEDS OF DBPH USERS*

Year	Expected Number of Individual Cassette Book Readers	Standard Error of Prediction of Col. 2 (90% Confidence Level)	Expected Number of Deposit Collection Cassette Book Readers	Standard Error of Prediction of Col. 4 (90% Confidence Level)	Expected Number of Copies of All Cassette Books
1974	64,800	± 3,000	14,000	± 5,000	113,000
1975	66,700	±27,000	21,000	± 7,000	126,000
1976	79,100	±30,000	29,000	±10,000	156,000
1977	91,500	±34,000	38,000	±14,000	186,000
1978	104,000	±37,000	48,000	±19,000	219,000
1979	116,000	±41,000	60,000	±24,000	253,000
1980	129,000	±45,000	73,000	±30,000	291,000

*Projections Based on Present Service Ratios with Adjustments Included for Present Trends. It is assumed that of the 30,000 cassette players already ordered about 27,300 will go to new individual cassette readers during 1974 with the rest going to deposit collections or readers who already have an old cassette player.

meet the demands of the expected number of users of DBPH audio services, assuming the present media mix, the following operations were performed: The ratio of Talking Book record machines to cassette players was obtained for individual readers for 1974, and applied to the estimates of expected number of individual readers for the next six years to give projections of the number of Talking Book machines and cassette players required by individual readers for the years 1974 to 1980. It should be noted that this method assumes that each reader has one and only one Talking Book machine or cassette player (which seems reasonable) but can have one of each. These predictions are presented in Table VII, Col. 1 and 2. Then the ratios of Talking Book record machines and cassette players in deposit collections to readers served by deposit collections are calculated. (It is assumed that the average number of readers per deposit collection is 10. It is also assumed that the average number of machines per deposit collection is around 1.75. This estimate was derived from conversations with regional librarians.). Applying these ratios to the projected numbers of readers per machine served by deposit collections gives the projections of numbers of Talking Book record machines and cassette players in deposit collections for the years from 1974 to 1980. These predictions are presented in Table VII, Col. 3 and 4. Then the predictions of Talking Book machines used by individual readers and deposit collection readers are summed for the seven years and the predictions of cassette players used by individual readers and deposit collection readers are summed for the seven years, the totals being presented in Table VII, Col. 5 and 6.

The year-by-year estimates of the numbers of Talking Book and

TABLE VII

EXPECTED NUMBER OF TALKING BOOK MACHINES AND CASSETTE PLAYERS IN THE FIELD REQUIRED TO MEET THE DEMANDS OF THE EXPECTED NUMBER OF USERS OF DBPH AUDIO SERVICES, ASSUMING THE PRESENT MEDIA AND MACHINE MIX

Year	Expected Number of Talking Book Machines Loaned to Individuals	Expected Number of Cassette Book Machines Loaned to Individuals	Expected Number of Talking Book Machines in Deposit Collections	Expected Number of Cassette Book Machines in Deposit Collections	Expected Number of Talking Book Machines	Expected Number of Cassette Book Machines
1974	200,000	65,000	22,000	2,500	222,000	67,000
1975	214,000	68,000	25,800	2,900	240,000	71,000
1976	233,000	74,000	29,800	3,300	263,000	77,000
1977	252,000	80,000	33,900	3,800	286,000	84,000
1978	272,000	86,000	37,300	4,100	309,000	90,000
1979	291,000	92,000	41,900	4,600	333,000	97,000
1980	311,000	98,000	45,700	5,100	357,000	103,000

cassette machines in the field to meet the demand of the expected number of users of DBPH audio services, using the media mix predicted from estimates of the future numbers of Talking Books on records and on cassettes was obtained in the following manner: From the linear regression performed on the number of individual Talking Book record readers, using estimates of this number of the 6 years preceding 1974, predictions of the expected number of individual Talking Book readers for the years 1974 to 1980 were obtained. (See Table V). From the separate linear regression performed on the number of individual Cassette Book readers, using estimates of this number for the 6 years preceding 1975, predictions of the expected number of individual Cassette Book readers for the years 1974 to 1980 were obtained. (See Table VI) Assuming that each reader has one and only one Talking Book machine or cassette player but can have one of each, the estimated numbers of Talking Book machines and cassette players required for individual readers are calculated for the years 1974 to 1980. Then the ratios of the expected numbers of Talking Book record readers in deposit collections to the expected numbers of Cassette Book readers in deposit collections are applied to the projected numbers of readers per machine served by deposit collections, (See Table III), giving the projections of numbers of Talking Book machines and cassette players in deposit collections for the years from 1974 to 1980. Then the predictions of Talking Book machines used by individual readers and deposit collection readers are summed for each of the seven years and the predictions of cassette players used by individual readers and deposit collection readers are summed for the seven years, the totals

being presented in Table VIII.

Table VII represents the future expected situation which would result if no changes in the important factors (such as, split between Talking Book machines and cassette players) occured, but these estimates do not include the results of present trends. Table VIII represents the expected situation which would occur if no policy changes were made now by DBPH, and does include the expected effects of present trends (Such as the movement toward a larger proportion of cassette systems among individual readers.).

One large group of users will certainly be those with impaired manual dexterity. This group certainly needs player units that require little strength, agility, or dexterity to operate. Also, they certainly need a unit that is very easy to load. This seems to indicate that an easy-to-operate cassette is most appropriate for this group.

Another group of users with special needs would be those who are bedridden. A cassette would probably be most appropriate for this group too, due to its portability and due to the fact that, unlike a Talking Book machine, it does not have to be placed on a flat surface to operate well.

Still another group with special needs is the "mobile blind" students. This group also appears to require a light-weight, battery-operated portable cassette to allow listening in college buildings or libraries or on public transportation vehicles.

TABLE VIII

EXPECTED NUMBER OF TALKING BOOK MACHINES AND CASSETTE PLAYERS IN THE FIELD REQUIRED TO MEET THE DEMANDS OF THE EXPECTED NUMBER OF USERS OF DBPH AUDIO SERVICES, ASSUMING THE PROJECTED MEDIA AND MACHINE MIX, IF NO MAJOR POLICY CHANGES ARE INSTITUTED

Year	Expected Number of Talking Book Machines Loaned to Individuals	Expected Number of Cassette Book Machines Loaned to Individuals	Expected Number of Talking Book Machines in Deposit Collections	Expected Number of Cassette Book Machines in Deposit Collections	Expected Number of Talking Book Machines	Expected Number of Cassette Book Machines
1974	200,000	64,800	22,000	2,500	222,000	67,300
1975	215,000	66,700	25,000	3,700	240,000	70,400
1976	228,000	79,100	28,000	5,100	256,000	84,200
1977	241,000	91,500	31,000	6,700	272,000	98,200
1978	254,000	104,000	33,000	8,400	287,000	112,000
1979	267,000	116,000	36,000	10,500	303,000	126,000
1980	280,000	129,000	38,000	12,800	318,000	142,000

D. SUMMARY OF DATA ON PRODUCTION COSTS FOR RECORDING MEDIA AND PLAYBACK MACHINES FOR DBPH AUDIO SERVICES

Production cost data for recording media and playback machines for DBPH audio services was obtained from members of the DBPH staff, from various suppliers of media and equipment, such as the 3M Company, Ampex, and the Evatone Co., and from various institutions serving the blind, such as Science for the Blind and the American Printing House for the Blind

First, 1974 unit production costs for the various pieces of equipment and media for quantities in the range of interest to DBPH were obtained from the above sources, along with costs of media duplication and packaging. Then projections of these costs for the six years from 1975 to 1980 were obtained in the following manner: A linear regression was performed on unit production cost data for Talking Book machines for the five years preceding 1975; then predictions for unit production costs of Talking Book machines for the six years from 1975-80 were made from this linear regression. A second linear regression was then performed on unit production cost data for cassette players for 1969-71 and for 1973-74; then predictions for unit production costs of cassette players for the six years from 1975-80 were made from this linear regression. Insufficient past data on unit costs of other pieces of equipment or different types of media or packaging were found to justify performing any more regression analyses, so it was decided to predict their unit cost for the six years from 1975 to 1980 by assuming a 6% rate of inflation per year for these costs. This seems like a reasonable compromise in view of the current

economic situation. The predicted unit production costs for all equipment and different types of media and packaging are presented in Table IX. (No attempt was made to take random fluctuation in prices of parts into account.).

Then the anticipated year-by-year costs for the seven years from 1974-80 for playback machines and media in the quantities desired were calculated. Table X presents these expected year-by-year costs under the assumption that the present machine and media mix continues to hold for the period from 1974-80. It does not take account of present trends in usage of DBPH machines or media. Table X was derived from the predicted unit costs of the various media and machines presented in Table IX, from the predicted quantities of Talking Book record machines and cassette players presented in Table VII, from the predicted total number of readers presented in Table III, and from the present split in circulation between Hard Record Books and Cassette Books (1973 circulation of Talking Books on hard records is estimated at 6,920,000; and 1973 circulation of Cassette Books is estimated at 501,000.).

TABLE IX

ANTICIPATED YEAR-BY-YEAR UNIT COSTS OF DBPH

SUPPLIED MEDIA AND PLAYBACK MACHINES

Year	Expected Unit Cost of Talking Book Machines	Expected Unit Cost of Hard Records (Quantities of 1000) (Including Duplication Costs)	Expected Unit Packaging Cost of Hard Records	Expected Unit Cost of Flexible Discs (Quantities of 7000)	Expected Unit Handling and Packaging Costs of Flexible Discs
1974	$46.00	$.55	$1.02	$.12	$.05
1975	$50.90	$.58	$1.08	$.13	$.05
1976	$55.80	$.62	$1.14	$.13	$.06
1977	$60.80	$.65	$1.21	$.14	$.06
1978	$65.70	$.69	$1.28	$.15	$.06
1979	$70.60	$.74	$1.36	$.16	$.07
1980	$75.50	$.78	$1.44	$.17	$.07

TABLE IX (Cont'd)

ANTICIPATED YEAR-BY-YEAR UNIT COSTS OF DBPH

SUPPLIED MEDIA AND PLAYBACK MACHINES

Year	Expected Unit Cost of Accessory Disc Unit*	Expected Unit Cost of Cassette Players	Expected Unit Cost of Cassettes C-60	C-90	C-120	Expected Unit Duplication Costs of Cassettes (Batches of 20)	Expected Unit Packaging Costs of 1 7/8" Cassettes	Expected Unit Packaging Costs of 15/16" Cassettes
1974	$25.00	$54.50	$.63	$. 94	$1.36	$.60	$1.22	$1.10
1975	$26.50	$57.70	$.67	$1.00	$1.44	$.64	$1.29	$1.17
1976	$28.10	$60.90	$.71	$1.06	$1.53	$.68	$1.37	$1.24
1977	$29.80	$64.00	$.75	$1.12	$1.62	$.72	$1.45	$1.31
1978	$31.60	$67.20	$.80	$1.19	$1.72	$.76	$1.54	$1.39
1979	$33.50	$70.40	$.85	$1.26	$1.82	$.81	$1.63	$1.47
1980	$35.50	$73.50	$.90	$1.34	$1.93	$.86	$1.73	$1.56

*This estimate was obtained from the Technical Officer of DBPH.

TABLE X

ANTICIPATED YEAR-BY-YEAR COSTS FOR PROVIDING THE REQUIRED NUMBER OF PLAYBACK MACHINES, BOOKS, AND MAGAZINES, ASSUMING THE PRESENT MACHINE AND MEDIA MIX*

Year	Expected Total Costs of New Talking Book Machines	Expected Total Costs of New Cassette Players	Expected Total Costs of Talking Book Records	Expected Total Costs of DBPH Magazines	Expected Total Costs of Cassette Books
1974	$1,100,000	$1,580,000	$1,150,000	$1,500,000	$1,070,000
1975	$2,040,000	$ 635,000	$1,310,000	$1,640,000	$1,210,000
1976	$2,6[illegible],000	$ 792,000	$1,530,000	$1,460,000	$ 771,000
1977	$2,980,000	$ 896,000	$1,760,000	$1,650,000	$ 881,000
1978	$3,420,000	$1,010,000	$2,010,000	$1,840,000	$1,010,000
1979	$3,880,000	$1,130,000	$2,310,000	$2,080,000	$1,160,000
1980	$4,300,000	$1,180,000	$2,610,000	$2,300,000	$1,300,000

*It is assumed that 10% of the playback machines of each type will have to be replaced each year. A mean of 2.5 hard records are assumed to be required for each book. It is also assumed that in 1974-75, 2-track, 15/16 ips C-90 cassettes will be used, while from 1976-80, 4-track, 15/16 ips C-90 cassettes will be used. It is assumed that from 1974-76 magazines will be on both hard records and flexible discs in the same proportion as at present; but from 1976 on, all magazines will be on flexible discs. It is also assumed that the mean length of magazines is three hours.

E. RECORDING MEDIA ALTERNATIVES

1. The Question of Two Media Formats

Although the DBPH began its listening services program with the use of records for Talking Books, by 1970 cassettes were also introduced as a major medium. Records and cassettes, as used in their appropriate player units, have particular characteristics and advantages. They each have certain negative features as well. However, to have two principal media for Talking Books is not desirable. There are disadvantages to DBPH on the basis of operational complications, additional costs and there are difficulties for the user as well. A desirable step would be to adopt one media format and one type of playback machine if at all possible to do so. Any change that is to be made, however, must not result in a degradation of services or increased production costs or unacceptable constraints for the user.

2. Comparison of Record and Cassette Formats

A determination of whether one media or the other should be adopted for DBPH involves many factors, the characteristics of the media for performance and use, playback machine factors, cost factors, etc. In Figure 1, we summarize some of the positive and negative features associated with records and cassettes. Records give good audio quality. They offer a very condensed audio format. They, in their hard format, can be played many times. However, they are subject to scratching and wear. Records require set-up costs for production and are an indicated medium when large editions (say over 500) are required. Cassettes represent a very condensed audio format, give very good audio quality, can be replayed on an unlimited basis, and can be re-used if required.

FIGURE 1

COMPARISON OF AUDIO MEDIA

	Positive Factors	Negative Factors
Hard Records 8 rpm 10"	Fairly durable Condensed recording Very good audio quality Indicated for large editions	Shelving problems Expensive to ship Mild limitation on playings Subject to scratching and wear Production set-up costs
Flexible Discs 8 rpm 9"	Inexpensive to produce Inexpensive to ship Condensed recording Good audio quality Indicated for large editions	Not too durable Limitation on playings Subject to scratching and wear Production set-up costs
Cassettes 4-Track 15/16 ips	Very condensed recording Capable of many replayings Can be reused Very good audio quality Easily duplicated as required Indicated for small editions	"Spillage" problems with certain C-90 and C-120 designs Large editions more costly than records

They are very easily duplicated. However, a large edition would be mostly a multiplication of basic unit cassette costs.

A determination of whether cassettes or records should be used for future DBPH requirements must take into account not only the medium and its characteristics, but the matter of overall system costs and, of high importance, the performance of the medium in its playback unit to provide the DBPH service the user is looking for. If it were a matter of media costs only, and large editions of all items in the DBPH library, the record format has the advantage. However, on the basis of convenience, ability to play in all situations, availability of additional features (e.g., "record" mode), portability and general user acceptance, the cassette is the more desirable and attractive medium. Costs of production of cassettes may be slightly higher per unit; however duplication is easily done, and no large set-up costs are incurred as with record production. It is true too that not all DBPH book materials are issued in large editions so that the total production cost for a cassette edition may not be large. If additional copies are needed, these can be generated easily and economically. Our view is that cassettes are the medium of choice for future DBPH audio records.

3. Flexible Discs for Magazine Requirements

Although we do believe that circulating book materials should be handled entirely on cassettes in the future, we think too that a good case can be made to continue the distribution of magazines, Talking Book Topics and other large-edition news items on flexible discs. Flexible discs are produced at very low cost in large

editions. Although they do not have good wearing qualities, they do give a condensed format and are satisfactory in quality for a few playings. We believe the use of flexible discs for magazines should be restricted to "direct circulation" only since it is not intended that these formats be circulated to more than one user.

4. Reliability of Cassettes

A question can be raised whether cassettes have proven sufficiently reliable to be considered as a major audio medium for the DBPH. There have been problems in the use of cassettes and the DBPH has experienced difficulties too in the past year or so. In certain cassettes there is a tendency for "spillage" --a failur of the take-up spool to continue take-up of tape resulting in a "spillage" of tape and further complications caused by the tape winding about portions of the playback machine and jamming the unit. (This is according to private communications from the Technical Officer of DBPH.) There is a tendency for "spillage" (if it does occur) to occur more often in C90 and C120 cassettes rather than in the C60 type. This factor is related to the fact that C60 cassettes have a tape base which is of greater thickness than that in the C90 or C120 cassette, and is somewhat less flexible. Our studies have indicated that "spillage" is a problem induced by undesirable friction in the cassette, which in turn is related to the internal design of the cassette. Where a cassette has been carefully designed, where there has been attention to the special design of tape guides and drive mechanisms, the occurrence of "spillage" is largely eliminated. In our view, most of the problems encountered by DBPH with its cassette usage

can be eliminated by tighter quality control, and the possible modification of its current specifications. We do not believe this is a sufficiently serious problem to hold up any planned usage of cassettes in the DBPH program. Since occurrence of "spillage" is very rare in C60 cassettes, these might be used for an interim period if the problem with C90 cassettes persists in those currently in use.

5. Comparison of 2-Track, 1 7/8 ips and 4-Track, 15/16 ips Cassette Formats

The proposed changeover from 2-Track, 1 7/8 ips cassette format to the 4-Track, 15/16 ips format will effect a four-time condensation of a DBPH recording. This is a most desirable step to take in order to reduce media production costs. The change does require the availability of a 2-speed playback unit if material in the old format is to continue to be used for any time period.

After consultation with cassette manufacturers and study by our Technical Staff, we have concluded that the proposed change does not involve any undue risks. The change does not involve any significant degradation in audio quality. The indexing problem for four tracks will not be difficult to achieve since fixed heads will be used which give an inherently stable system.

6. Comparison of Usage of Book and Magazine Formats

DBPH provides its users with two formats of audio service, the Talking Book and magazines. Talking Books differ from magazines in that they are usually much longer; on the average DBPH Talking Books are around twice as long as DBPH magazines. Also DBPH Talking Books can be profitably read by users anytime after publi-

cation by DBPH; whereas DBPH magazines, particularly news magazines, are often worthwhile to read only within a week or so after publication. The timeliness of the reading material is a very important factor with many magazines, but is not such an important factor for books. This implies that a special effort must be made to provide users with any magazines they desire within a short time after publication; no special effort seems necessary where books are concerned. The special effort required to provide readers with magazines as soon as possible after publication implies some decrease in the quality of spoken magazines compared to books, but this is expected and allowed for. This special effort would also imply less elaborate packaging and less careful handling.

DBPH Talking Books also differ from DBPH magazines in that Talking Books must permit some repetitive use, where magazines will usually only be played once or a very few times. A person will usually only want to play a magazine once, whereas he may well wish to play a book two or more times. Also, because books are longer and thus more expensive and difficult to produce, it seems desirable that Talking Books must be capable of withstanding repetitive use (by different users possibly). They must be sufficiently durable that they can be played a number of times; whereas magazines need to be far less durable since they usually only need to withstand one or two playings.

7. Possible Alternatives to Book and Magazine Formats

It has been assumed up until now that there were only two major forms of recording - the Talking Book, of approximately 6 hours length and repetitive use, and the magazine, of approximately 3 hours length and only 1 or a few playings. To determine whether

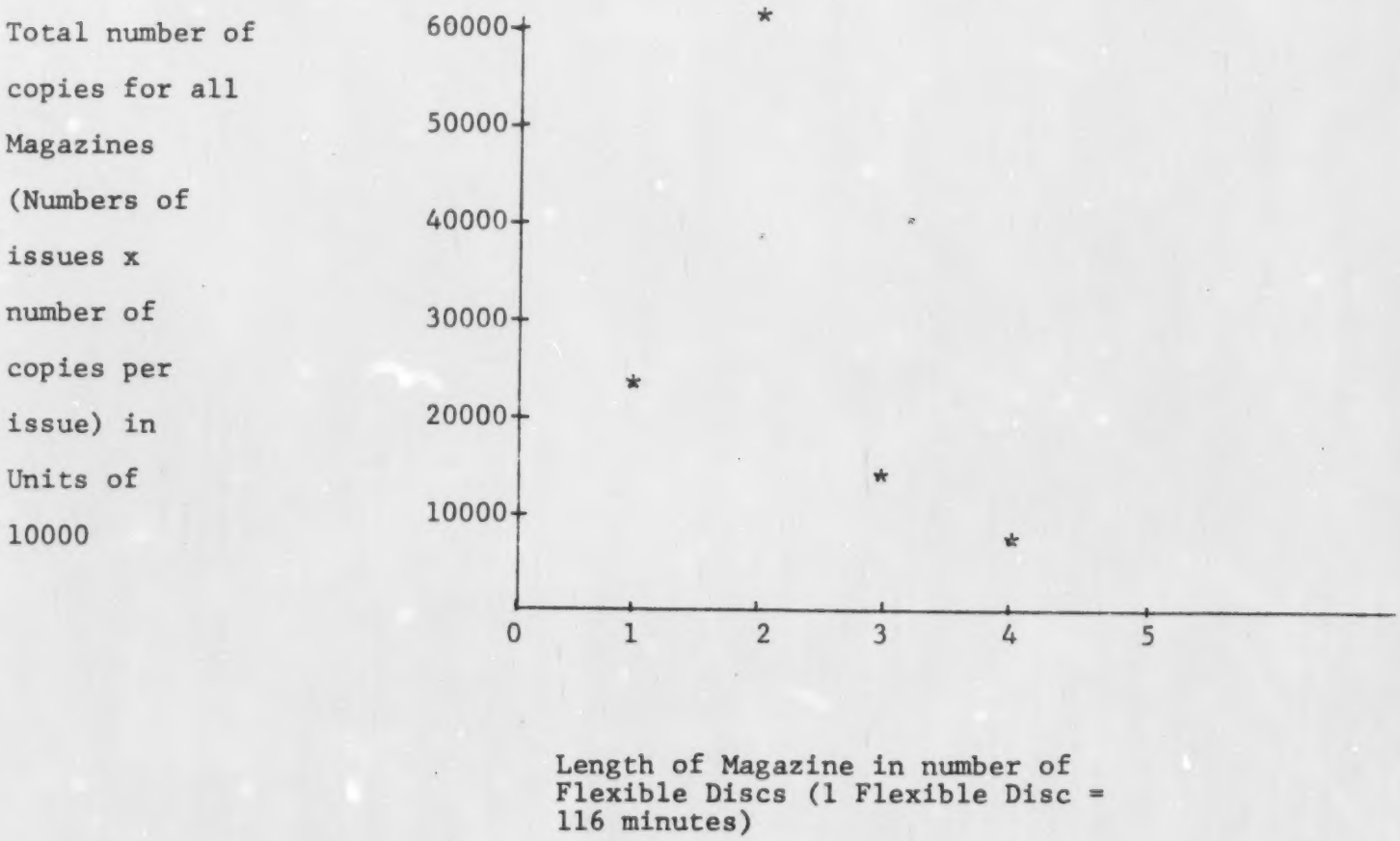
these two major clusters are a reasonable approximation to the true situation, or if not, to establish an improved characterization, statistics on the lengths of the various items disseminated by DBPH were gathered and analyzed. The appropriate statistics on Talking Book titles, Cassette Book titles, and magazines - the number of copies of each produced and the number of records employed for each - for the month of November, 1973, were analyzed.

For the magazines disseminated during November, 1973, the total number of copies - the number of copies of each magazine multiplied by the number of issues - for all magazines was plotted against the corresponding number of discs required and statistics on this distribution were calculated. (See Figure 2). The mean of this distribution was 2.04 or approximately 2 and its standard deviation was .79. Since each side of the flexible discs on which the magazines are published is, on the average, of 58 minutes duration, and since, on the average, only one whole side of the second record of a magazine will be recorded, the mean number of minutes per magazine is 3 x 58 = 174 minutes which is approximately equal to 3 hours. Since the standard deviation of the distribution for magazines is fairly small, the distribution of magazines is quite concentrated about its mean of 3 hours. Thus it seems reasonable to conclude that the length of DBPH magazines can indeed be approximated fairly well by considering all of them to be of 3 hours length. Magazines will usually only be read a few times, so it is reasonable to publish them on flexible discs which are not too durable but are much less expensive to produce.

For the Talking Books and Cassette Books produced during

FIGURE 2

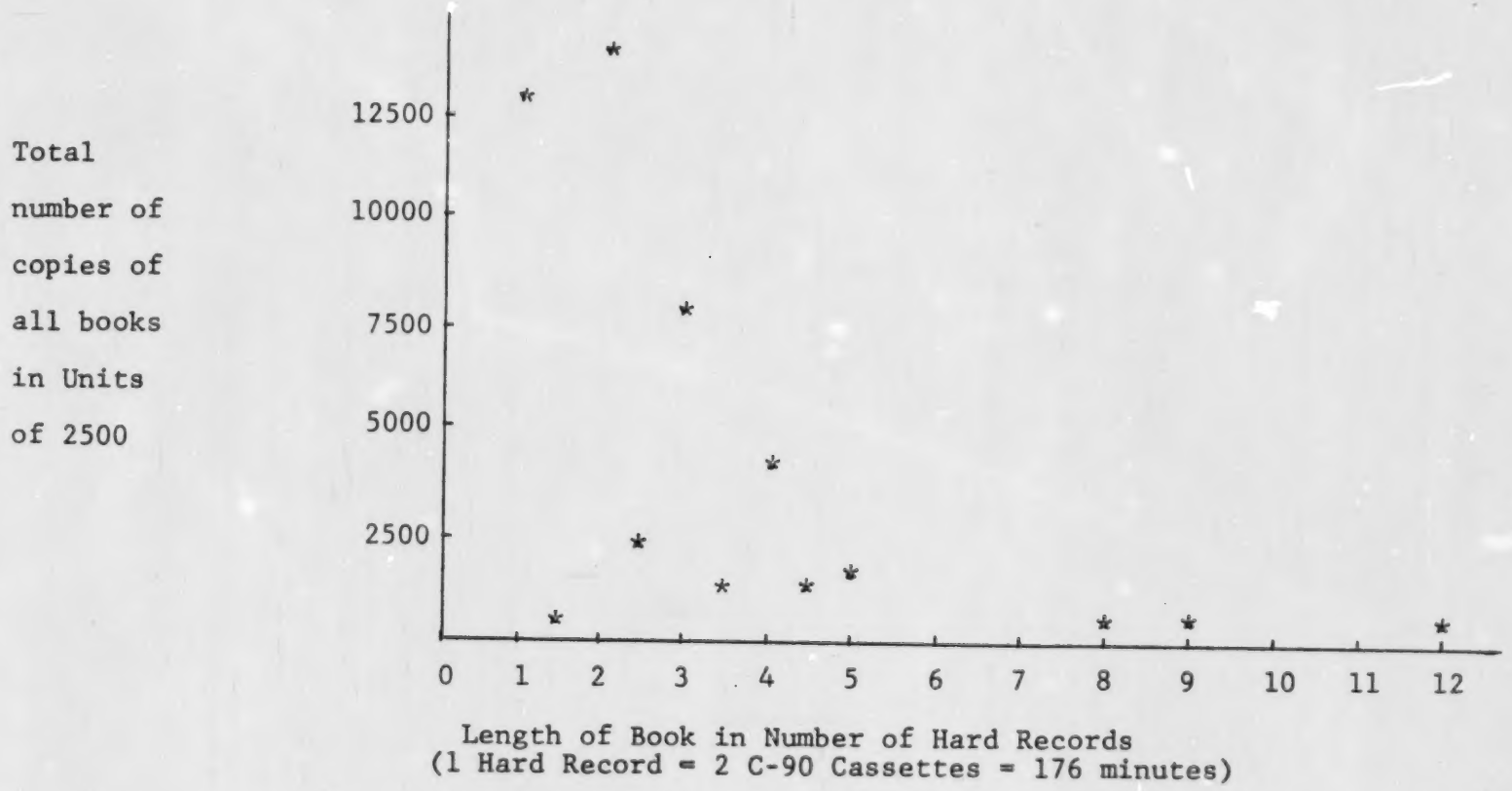
DISTRIBUTION OF DBPH SUPPLIED MAGAZINES BY LENGTH



November, 1973, the total number of copies for all titles was plotted against the corresponding number of discs or cassettes required and statistics on this distribution were calculated. (See Figure 3) (The Sagrada Biblia, N.T. (Part F) with 73 records per copy was omitted from the list of titles since its inclusion would certainly have severely biased the distribution and since its publication was considered uncommon.). Care had to be taken in calculating the totals since, while one side of a Talking Book hard record is of 88 minutes or approximately 1½ hours length, an entire C-90 cassette is of 1½ hours length. The mean of this distribution is 2.54 which is equivalent to around 7½ hours playing time. (This value for the mean playing length of the DBPH Talking Book distribution is confirmed by an analysis of the distribution by number of records of all Talking Books on records issued by DBPH during the year 1973. The mean number of records for all Talking Books issued during 1973 is 2.9 which is approximately equivalent to 8.5 hours of playing time. Thus, on the basis of the approximate equality of the means of the Talking Book distribution for November 1973, and of the Talking Book record distribution for all of 1973, it can be concluded, that statistics on Talking Book length for November, 1973, are fairly representative of statistics on Talking Book length for a year.). However, the standard deviation of this distribution is 1.74. Because of this high value for the standard deviation of the distribution by length of Talking Book records and Cassette Books, it is not reasonable to approximate them by a standard Talking Book of some fixed length. Thus, the previously-used Talking Book characterization seems inappropriate.

FIGURE 3

DISTRIBUTION OF DBPH SUPPLIED TALKING BOOKS AND CASSETTE BOOKS BY LENGTH



From our viewpoint it would be useful if DBPH books (either records or cassettes) would be divided into two categories: "short books" and "long books". "Short books" would consist of all titles less than 12 hours long which could therefore fit into 4 hard records or 8 C-90 cassettes; "long books" would be all those titles requiring more than "short book" recording space. When the statistics on just the short books are calculated, it is found that the mean of the short books distribution is 2.14 or approximately 2 which equals 4 x 88 minutes or 352 minutes or about 6 hours; and the standard deviation is .96. Since the standard deviation of the distribution for short books is fairly small, the distribution of short books is quite concentrated about its mean of 6 hours. Thus, it seems reasonable to conclude that short books can indeed be approximated well by considering them to be of 6 hours length.

The distinction between short and long Talking Books seems to be fairly important and beneficial, since smaller more compact packages could be used for the short books, reserving large packages for long books and thus saving some of the packaging and handling costs and effort. Also, the use of smaller packages for short books would save substantial storage space in libraries and users' homes. However, these advantages would be partially offset anyway by the disadvantages of having to produce and handle two different sizes of containers. Fixed production costs would certainly be higher for two containers than for one.

8. Desirable Media Characteristics for DBPH - Summary

In summary, it is our estimate that it would be both efficient

and economical for DBPH to record all of its Talking Books on cassettes rather than on hard records. It appears that the cost of producing, packaging and shipping cassettes will eventually become roughly equal to the cost of producing, packaging and shipping hard records. (Calculations based on the unit costs given in Table IX indicate that in 1976 the cost of producing, packaging and shipping the typical DBPH Talking Book will be $2.69 if on hard records and $3.41 if on cassettes.). So, because cassettes seem to be preferred by DBPH users for their portability, ease of use outside the home and overall convenience, they appear to be preferable to hard records. However, because many DBPH users are unfamiliar with cassette systems and thus prefer record playing systems, and because of the large number of record playing systems loaned to users that cannont be swiftly replaced with cassette systems, record playing systems for books should be phased out gradually. It will be difficult for DBPH to suddenly shift to an all cassette system for their Talking Books. The problem of building up a larger library of Cassette Books will take some time to solve. Thus, it is reasonable that DBPH continue to supply its users with both record player maintenance and books on hard records for a limited period. However, DBPH should move to an all cassette system for books as soon as possible.

It appears desirable for the media used by DBPH to be as condensed and compact as possible, in order to economize on packaging and handling costs and to provide convenient easily stored Talking Books and magazines. Packaging and handling costs are an important factor in the total cost of providing users with Talking Books and

magazines. Packaging and handling costs are an important factor in the total cost of providing users with Talking Books and magazines, as shown in Section D above. Also, reducing the amount of storage required for Talking Books is important to both the DBPH and the regional libraries. Cassettes appear to be very desirable for Talking Books due to their advantages of portability, ease of usage outside the home and overall convenience. The problems experienced by DBPH users with cassettes can be overcome in fairly short order. Also, it is desirable that magazines and Talking Book Topics continue to be recorded and distributed on flexible discs, since the basic costs to use this medium are very attractive for the purposes intended.

F. ROLE OF DBPH WITH RESPECT TO PRODUCTION AND DISTRIBUTION OF MACHINES

1. Rationale for Machine Distribution by DBPH

From one point of view it would be desirable for DBPH not to be involved in the distribution of playback machines but to allow each user to obtain his own machine from a commercial source. In its program to minimize overall costs, however, DBPH has moved in the direction of the most condensed format. To use condensed formats (which do lower production costs greatly) DBPH has had to use a playback machine which is not commercially available. If it wants to continue to use condensed formats, records (8 rpm) or cassettes (4-Track, 15/16 ips), it will have to provide the playback machines. If there were a move in the direction of less condensed formats playable on commercial machines, media production costs would be multiplied. If DBPH would not supply commercial machines, costs to the user for machines might mean that many people in lower economic levels would not be able to participate in the DBPH program at all.

In Table XI we give estimated production costs for DBPH for the case where only media are supplied to users and no machine, and where the media for books and magazines is in commercial format only. Table XI reflects costs for the projected number of titles and copies for the year 1976. Two cost alternatives are considered, one for the 2-media situation: cassettes for books and flexible discs for magazines; the second alternative reflects costs for books and magazines on cassettes only. For the case where two media are used, a user will of course need to acquire two different

TABLE XI

ESTIMATED COSTS OF SUPPLYING MEDIA ONLY (BOOKS AND MAGAZINES IN COMMERCIAL FORMAT) FOR COMMERCIALLY AVAILABLE MACHINES FOR 1976

	Cost of Books -1976 (Books on 1 7/8 ips, 2-trk, C90 Cassettes)	Cost of Magazines on Appropriate Media-1976 (Magazines either on 9" 16 2/3 rpm discs or 1 7/8 ips, 2-trk, C60 Cassettes)	Total Cost of Media of Both Formats-Books and Magazines -1976	Comparative Total Costs of All Media and Machines Required - 1976 (Books on 15/16 ips, 4-Trk, C90 Cassettes, Magazines either on 9", 8 1/3 rpm discs or 15/16 ips, 4-Trk , C60 Cassettes; Cassette Players supplied with or without accessory disc unit as indicated).
Books on Cassettes, Magazines on Flexible Discs*	$12,300,000	$ 2,100,000	$14,400,000	$11,700,000
Books on Cassettes, Magazines on Short Cassettes	$12,300,000	$18,200,000	$30,500,000	$16,900,000

*This option requires that users have both a cassette player and record player available.

playback machines, which is an undesirable requirement.

For comparative purposes Table XI also includes total production cost estimates for DBPH for 1976 where both media (in condensed non-commercial format) and machines are supplied to users. The same number of titles and copies are included in the estimate. It will be noted that total costs are more favorable for the case where both media (condensed format) and machines are supplied.

2. Determinative Role of DBPH in Non-Commercial Service

Because it is the sole distributor of a unique medium, DBPH is in a position to have a playback machine designed to accomodate its particular media format. DBPH is thus able to set standards and to arrive at a media-machine mix which will best meet cost and performance requirements without regard to commercial restraints. If DBPH were to be using commercial media or equipment, it would have very much less flexibility to make constructive changes in its program. It is very undesirable of course to make frequent changes, which do have serious effects on both operations and users.

3. Basis for Choice of Preferred Playback Machine

It is difficult to separate the question of playback machine choice from considerations involving the media. Factors involving relative costs or audio performance do not result in a determination one way or the other. However, when we consider each medium (records or cassettes) and the spectrum of usage possible in each of the respective playback machines, some significant conclusions can be made.

Our survey has indicated that many audio users have a preference for cassette playback machines over record playback machines. Reasons

for this preference relate to factors of overall convenience, portability, ability to use and play in a wider variety of situations, and availability of additional features such as "record mode", etc..

The record format does have some advantageous characteristics. It does give a condensed format and it can be produced at very low cost in large editions. However, DBPH must make a determination about which medium it will use in the future. It is undesirable to have two media especially for its circulating book collection. To minimize costs it is desirable to minimize formats and media equipments to be used. If a choice has to be made for a principal medium, our choice would be cassettes and the associated cassette player. Convenience and user acceptability are overriding considerations. The question of higher costs of cassettes over records is offset by the point that some DBPH book editions do not require large editions (which optimize record costs) and cassettes lend themselves to rapid and easily facilitated duplication. As demand for a particular title builds up, additional copies can readily be supplied from a duplication facility.

Although we would propose that cassettes be the one medium for DBPH book circulation purposes, where there are requirements to produce large editions and these can be handled on a direct distribution basis, we believe the low cost of flexible disc records is so attractive that it should be continued in the program although it does complicate the machine production picture. To minimize machine costs we propose that the cassette player be considered basic and that it be designed so that its control and audio circuitry could be used for an accessory plug-in disc turntable unit for

flexible discs. We do not rule out the possibility of a combination cassette and record (disc) playback machine; however, we do believe it is a design advantage to have the disc turntable and arm mechanism constructed in such a way that it can be readily detached from the cassette player. A plug-in approach for an accessory disc playback unit makes it possible thus to retain maximum portability for the cassette player component and minimizes its performance constraints. Preliminary studies by our own staff and by the Technical Staff of DBPH have shown that the costs for an accessory disc unit could be lower than that for a combination cassette and disc playback machine. In our view the use of discs should be limited only to "direct circulation" situations for large editions. When and if the day comes when cassette costs can be lowered sufficiently in the future, the use of flexible discs should be phased out of the program.

4. "Basic" vs "Additional" Features on Playback Machines

The charter under which DBPH functions, provides that "sound reproducers" should be provided to give needed audio services. A basic capability for playback should be provided but it is doubtful that DBPH has any justification to provide additional features which may be desired by audio users. It is true that users of DBPH audio services have other uses to make of cassette machines. Some desire a "record mode", speed control, microphone, rechargeable battery, etc.. In our view DBPH should provide a basic machine only. If additional features can be added at little or no cost, these would be desirable to include in the basic machine. However, where additional features do run into appreciable costs, these

should be made available, but the costs should be absorbed by the user. DBPH should attempt to arrange with equipment vendors for the availability of optional features which should be obtainable at a minimal cost to the DBPH user population.

5. Cost Projections for Different Machine Options

Cost projections were derived for three different machine options: The Talking Book machine for hard records, the cassette player, and the basic cassette player system with the accessory disc unit. The cost projections for the seven years from 1974-1980 for these three machine options are presented in Table IX. The projected total cost of the basic cassette player with the accessory disc unit for any particular year can be found by adding together the costs for the cassette player and for the accessory disc unit for that year.

G. IMPACT OF EVOLVING TECHNOLOGY ON DBPH AUDIO SERVICES

1. Technology Trends

The technology which relates to an audio services operation continues to undergo rapid change. New technology has made possible the DBPH use of condensed formats and improved machines over a period of years. Recent progress now makes possible another condensation step to a 4-Track cassette with 15/16 ips speed format which provides a four-time condensation advantage over the 2-Track and 1 7/8 ips format currently being used. Use of 8-Track cassettes is being made in Great Britain, and the use of cassettes at 15/32 ips is being applied by the Los Angeles Police Department.

The rapid application of LSI (Large Scale Integration) circuitry using semiconductor technology will be leading to the eventual lowering of hardware costs for all types of processing and control devices. For instance, it will soon be possible to provide low-cost speed control devices for audio play-back machines which can effect speed changes without change of pitch. Cambridge Research and Development Group of Westport, Conn. reports on the early availability of such a device implemented on a single LSI chip. Greater compactness of play-back machines as well as lowered costs will be a reasonable prospect as LSI continues to be applied.

Aside from the audio equipment and media area, probably greater changes are in prospect for the means for distribution of audio services. Cable TV, which is now serving some 8,000,000 people in thousands of systems in the U.S.A., will provide the availability of multiple channels for broadcast of audio books.

However, this is probably not as significant as the possible use of interactive cable systems, where a user requests a particular item held in a regional center, by dialing a particular request signal.

FM sub-carrier systems also present interesting possibilities. A users could dial a particular library center and request the transmission of a particular audio recording. This would be sent by the library center by means of the area FM station over a particular sub-carrier beam and picked up by the FM receiver at the user's location. The user's receiver would have a recording and play-back capability. What is important is that the transmission to the user, which is over a wide-band link, can be made at high speed, possibly in a few minutes for an entire book. The play-back could be made by the user in the usual way. It will of course require specialized sending and receiving equipment to make this possible. The FM capabilities are largely available now.

2. Assessment of Cassette Technology

Although cassettes were introduced in 1960, they did not really become a significant medium until 1968. At the present time, their use is proliferating at a very great rate. The question of cassette reliability was discussed in Section E above in connection with recording media alternatives. Our conclusions are that the C90 4-Track cassette with 15/16 ips is a desirable and reliable medium for future DBPH book circulation.

Since a 4-Track 15/16 ips cassette format has been proposed as a principal format for DBPH use, what prospects are there that this may soon be replaced by another format, say 8-Track or a

15/32 ips speed? While it is true that 8-Track cassettes are in use, these usually involve a shifting mechanism to position the recording heads. Thus an increased amount of risk is introduced into the system. Current 4-Track designs make use of fixed head positions which are inherently stable. A 15/32 ips speed can be useful for certain purposes involving voice messages, but the signal to noise ratio at this speed is beginning to move the system into a very marginal area as far as adequate quality is concerned. In our view, the 4-Track cassette with 15/16 ips speed represents a format which makes possible good audio reproduction quality for DBPH purposes. It does not make unreasonable demands on the present technology. We believe this format has the prospect of remaining in effect for a long period because it does provide a package (of a book recording) for the user which is small, convenient, and satisfying. There will not be a great deal of incentive to go beyond this package size to achieve any greater condensation because there will be little gain for the producer, distributor or user.

3. Impact of New Technology on DBPH Audio Services

Any change in the direction of a more condensed format for cassettes, by increasing the number of tracks or using slower tape speeds, results in various operational problems. New play-back machines must be produced and multiple speeds must be provided on each machine to make older formats usable. These problems are all offset by the advantages of more condensed package and lower media production costs.

Any new method of distribution for the delivery of DBPH audio

materials must present advantages over the postal delivery system now being used. Although no direct costs for postal service are now being applied, there is a possibility that these costs may have to be applied in the future. Cable TV and FM sub-carrier distribution, if these come into widespread use, will offer a different kind of service which in fact will not replace or compete with the present postal system. There is the likelihood that Cable systems could provide a certain type of audio service which would meet the needs of some of the DBPH user population; but the basic audio services, such as are now being offered, in our view, would continue to be an essential operation.

Our estimate is that widespread proliferation of cable and FM sub-carrier systems would modify the kinds of DBPH use patterns but would not replace them. Any adoption of services using these technologies would require the investment of considerable funds to provide special receiver devices, and these devices would only be usable on a cable system or within range of an FM sub-carrier, and in an area where electric power is available.

Probably of more significance for possible impact on the present DBPH audio services pattern would be the development of low-cost compact play-back units applying the advantages of LSI. A definite probability too are new recording materials which achieve extreme packing of digital data by newly developed methods (e.g., the H.R.M.R. microfiche made with the use of holographic methods.). These would require specially designed devices for individual play-back, but the format would be extremely condensed, easily distributed and stored and capable of much repetitive usage. It is

not likely that costs will be lowered to the point where these possibilities will be realized for, say, some 10 years. We do believe that these developments will definitely be coming, however, and will eventually displace the present media and equipments (13).

H. OBSOLESCENCE AND REPLACEMENT FACTORS FOR PLAYBACK MACHINES

The rates of obsolescence of the Talking Book record machines and the cassette players, or alternatively, the rates at which Talking Book machines and cassette players have to be replaced are a factor of importance in future planning for DBPH. The rates at which the two types of machines have to be replaced are an important determinant of the level of DBPH purchases of new machines. However, these rates are difficult to determine, due principally to the use of different production runs of Talking Book machines (6 different production runs of Talking Book machines have been issued since 1970.) and also different production runs of cassette players (5 different production runs of cassette players have been issued since 1969.). Each of these production runs of playback machines has its own particular characteristics and thus its own peculiar rate of obsolescence. Thus,to determine the overall rate of obsolescence for either Talking Book machines or cassette players would require the determination of the obsolescence rate of each production run, multiplying that by the number of machines from this production run in the field, summing these products, and then dividing by the total number of machines. Such determination goes well beyond the data available. Some data on the rates of repair of the various production runs are indeed available, but going from an estimate of a repair rate based on a small sample, to an obsolescence rate of a production run is not a valid evaluation. Also, even if obsolescence rates for the Talking Book machines and the cassette players issued in the past could be obtained, they would give no reliable indication of obsolescence rates of new production runs or new models

in the future.

However, it does seem worthwhile for the DBPH to obtain all possible information on obsolescence and repair rates of the various playback machines since such information will allow DBPH to change its suppliers of machines or to force its suppliers to improve their product. The gathering of statistical information on obsolescence rates and repairs should be an important part of the DBPH quality control program.

A 10-year life expectancy for playback machines is a reasonable goal for DBPH to set for its suppliers. If such a life expectancy is achieved, many DBPH users will not have to have their machines replaced. It should be mentioned that certain production runs of the Talking Book machine have very high repair rates and this implies rapid obsolescence. (One estimate by a Pioneer group leader of the mean period between repairs for a certain Talking Book machine production run was five months following the initial servicing, which occured on the average about a year after the machine was received from the factory). The existence of certain high obsolescence rates implies that a 10-year life expectancy for all Talking Book machines may be high.

In previous sections of this report it has been recommended that there be a switchover from Talking Book machines to cassette players for the DBPH circulating book program. This switchover will certainly have a definite effect on many DBPH users, and the change should be effected carefully. Because relatively few cassette players are now available to DBPH users and relatively few book titles have been recorded on cassettes, it is desirable not to phase out the use of Talking Book machines at once. Talking Book machines should be

supplied to requestors if available in stock. Repairs of Talking Book machines should be continued and Talking Book titles on records still in the production cycle should still be distributed.

Replacement policies during the changeover period should concentrate on supplying cassette players to those users who have requested them, rather than attempting to persuade satisfied Talking Book machine users to change machines. This appears necessary in view of the great demand for cassette players and the current backlog of requests. Also, it seems desirable to attempt to place as many cassette players as possible in deposit collections during the changeover period. In deposit collections, which are often in nursing homes, the advantages of the cassette players - ease of usage in bed, overall convenience, and portability - become most desirable. Following the changeover period, Talking Book machines should be replaced as fast as possible with cassette players and accessory disc units. In any case, we believe early action should be taken to make available accessory disc units to be used with the basic cassette machines so that existing Talking Book records can continue to be used while the Cassette Book library is being expanded. The accessory disc unit will be an important factor in assisting users in the changeover period.

User demands for new machines, particularly cassette players, do cause some subjective obsolescence in the Talking Book machines. However, this desire for new machines is partially offset by resistance among certain users (particularly older users) to change. Some users do indeed seem to prefer to use machines with which they are familiar, i.e., Talking Book record players. Thus, the policy of supplying cassette players to users that ask for them, but not insisting that

users accept cassette players if they do not request them, appears to be a good policy for the transition period.

The changeover from 2-Track, 1 7/8 ips cassettes to 4-Track, 15/16 ips cassettes will require that a two-speed machine be available (15/16 ips and 1 7/8 ips speeds). Since a number of 2-Track cassettes running at 1 7/8 ips speeds have already been issued to regional libraries and to users, provision should be made when 4-Track 15/16 ips formats are introduced, to ensure that the new machine also has capabilities to play older 2-Track, 1 7/8 ips cassettes. It will be desirable to continue to make full use of all Cassette Books that are already in the field.

The repair of users' Talking Book machines or cassette players when defective is of tremendous importance in ensuring the success of DBPH audio service programs. Repair of user's Talking Book machines or cassette players must be performed rapidly. The speed at which repairs are effected relates to the minimal degree of quality acceptable in Talking Book machines and cassette players distributed by the DBPH. If repairs are made fairly rapidly and are done successfully, a lower quality (and less costly) machine can be tolerated by DBPH than if repairs are slow and unsuccessful. Thus, it is the quality and success of the repair program that affects to some degree DBPH's policy on purchasing Talking Book machines and cassette players.

Repairs to DBPH Talking Book machines and cassette players are usually made in the following manner: The user mails a machine that is inoperative to the nearest regional center for machine repair. There, volunteers repair the machine, replacing any damaged or bad parts from stocks of parts kept at the machine repair center, and then the machine

is returned by mail to the user. Volunteers do not usually go to a user's home to repair an inoperative machine; the machine must be sent to the regional center for repair. Since all inoperative machines must be sent by the users to one regional center, and since we can consider each volunteer to be assigned to the machines from one subregion, we can consider the situation on the average to be very similar to the servicing of machines by a single repairman, in spite of the fact that more than one volunteer is usually available. The servicing of DBPH Talking Book machines and cassette players is thus analogous to a well known operations research problem whose mathematical solution has been determined. (See Feller, William, An Introduction to Probability Theory and Its Application, Wiley, Second Edition, Vol. 1, 1965, pp. 416-419). Some results derived from this theory will now be presented.

Statistics on the number of Talking Book record machines repaired in the four years from 1970-73 indicate that the probability of a particular machine needing repairs during any particular week is around .00050. The probability that a particular Talking Book machine will need repairs in a year is around .18; or in other words, on the average, 18% of all Talking Book machines will need repairs at some point during a year. Statistics on the number of cassette players repaired during the four years from 1970-73 indicate that the probability of a particular player needing repairs during any particular week is around .00039. The probability that a particular cassette player will need repairs in a year is around .14; or, on the average, 14% of all cassette players will need repairs at some point during a year. A comparison of the probabilities for equal numbers of Talking Book machines and cassette players needing repairs

indicates that cassette players only need about 3/4 as many repairs as Talking Book machines, or that cassette players appear to be about 28% more reliable than Talking Book machines. However, this difference is probably explained in large part by the fact that on the average Talking Book machines are much older than cassette players and therefore far more likely to need frequent repairs. Cassette players were only introduced in 1970 and are only on the average 1.5 years old, whereas Talking Book machines are on the average around 4.8 years old, or more than three times as old as cassette players.

An analysis of the process of submitting either a Talking Book machine or a cassette player for repairs, mailing the machine to a regional center, having the machine serviced by a volunteer, and then mailing the repaired machine to the user, indicates that an appropriate value for the probability that a machine will be repaired at the next repair session and then returned to the user in about a 10 or 11 day period, is around .67. (This assumes that all parts needed to repair the machine are immediately available at the regional center). It is now possible, for a given number of machines, to calculate the expected number of machines waiting for service from a particular volunteer using the approximate formula for large numbers of machines:

$$w = m - \frac{\lambda + \mu}{\lambda}$$

where w = the expected number of machines waiting to be serviced by a volunteer, m = the total number of machines assigned for possible servicing to a volunteer, λ = the probability that a particular

machine will need repairs during any particular day, and μ = the probability that a machine needing repairs will be returned to the user repaired within 10 days. Inserting the probabilities for Talking Book record machines indicates, that in order to avoid waiting lines of more than 10 or 20 per volunteer, the number of machines in the field which shall be the responsibility of one volunteer should, on the average, not be more than 1300 or 1400. Inserting the probabilities for cassette players indicates that, in order to avoid waiting lines of more than 10 or 20 per volunteer, the number of machines in the field which shall be the responsibility of one volunteer, should on the average, not be more than 1700 or 1800. These figures should enable volunteer groups to estimate whether or not they need more members to repair all the damaged machines expeditiously.

As stated before, during the changeover period, only those users requesting cassette players should receive them, and the number of cassette players in deposit collections should be expanded. Following this transition period, Talking Book record players should be replaced with cassette players as fast as possible. Replacement of record players with cassette players should be a high priority concern for DBPH in the period from 1974-80. Replacement of P% of record players with cassette players would imply a total cost for a year equal to $\frac{P}{100}$ X (number of record players remaining that year) X (cost per cassette player that year) + $\frac{P}{167}$ X (number of record players remaining that year) X (cost per accessory disc unit that year) + $\frac{P}{100}$ X (number of record players remaining that year) X 1.8 X (cost per copy of an average cassette book that year).

(This assumes that 60% of the readers who obtain new cassette players will want to have the accessory disc units also, and that the current ratio of 1.8 copies of Cassette Books to cassette users will continue to hold). (If it is assumed that about 75% of the readers who obtain new cassette players will want to have the accessory disc unit also and once more that the current ratio of 1.8 copies of Cassette Books to cassette users will continue to hold, the factor of $\frac{P}{167}$ in the second term in the above formula becomes $\frac{P}{133}$).

I. DECISION MATRIX FOR MAJOR FACTORS IN DBPH AUDIO SERVICE OPERATIONS

A two-part decision matrix listing in compact summary form the major factors in DBPH audio service operations, and giving the evaluations of those factors for the most probable system options will now be presented. This decision matrix can be very useful in identifying the optimal choice of system.

The principal factors in DBPH audio services operations have been divided into two classes: The cost of the equipment used in each of the system options as of 1976; the cost of the equipment used in each of the system options as of 1980 (This factor gives some indication of the future trends in equipment costs.); and the unit costs for each of the two principal media formats, books and magazines, as of 1976. The quality factors are as follows: The machine breakdown rate for the various system options which indicates the reliability of each system; the convenience to the user of each system indicated largely by the system's portability, ease of loading, and ease of use outside the home; the user acceptance of each system depending largely on the versatility of the system or the variety of uses to which it can be put and the user's desire for the latest or newest machines; the quality of the sound produced by each system; any operational problems or risks concomitant with use of the system; the ease of duplication of media in the field, important for ensuring rapid response to user requests for popular material; the storage and shelving of media for libraries, important in ensuring efficient library

operation; the rates at which the media used by the system wear out; and the possibility of reuse of the media, which may be of importance in ensuring economical operation of the service.

The five alternative sound reproduction systems to be evaluated are: An all record player system with books recorded on hard records and magazines on flexible discs; an all cassette player system using 4-Track 15/16 ips cassettes with books recorded on cassettes and magazines on short-tape-length cassettes; an all cassette player system using 2-Track 1 7/8 ips cassettes with books recorded on cassettes and magazines on short-tape-length cassettes; a basic cassette player system using 4-Track 15/16 ips cassettes with an accessory disc unit, books being recorded on cassettes and magazines on flexible discs; and a basic cassette player system using 2-Track 1 7/8 ips cassettes with an accessory disc unit, books being recorded on cassettes and magazines on flexible discs. These five alternative systems were considered to be the most reasonable alternative machine systems available to DBPH.

Table XII presents the evaluation of the five alternative sound reproduction systems in terms of the three cost factors, costs being given for each alternative system. Table XIII presents the evaluation of the five alternative sound reproduction systems in terms of the nine quality factors. Evaluations can not be easily presented in numerical form, so most evaluations of a system for a certain factor are made in terms of the rating system, excellent, good, fair, or poor. In addition, to the right of the evaluations of the five alternative systems are a set of numbers indicating the comparative order of importance of the corresponding factors. Thus,

TABLE XII

DECISION MATRIX FOR DBPH AUDIO PRODUCTS AND SERVICES

COST FACTORS

	All record player system (books on hard records, magazines on flexible discs)	All cassette player system (15/16 ips, 4-trk) (books on cassettes, magazines on short cassettes)	All cassette player system(1 7/8 ips, 2-trk) (books on cassettes, magazines on short cassettes)	Basic cassette player system (15/16 ips, 4-trk) with accessory disc unit (books on cassettes, magazines on flexible discs)	Basic cassette player system (1 7/8 ips, 2-trk) with accessory disc unit (books on cassettes, magazines on flexible discs)	Comparative Orders of Importance
System Equipment Cost-1976	$55.80	$61.00	$61.00	$ 89.10	$ 89.10	10
System Equipment Cost-1980	$73.50	$74.10	$74.10	$109.60	$109.60	6
Media (books, magazines) Costs-1976	$2.69 p/bk $ .32 p/mag	$3.41 p/bk $2.46 p/mag	$10.07 p/bk $ 5.54 p/mag	$3.41 p/bk $ .32 p/mag	$10.07 p/bk $ .32 p/mag	12

TABLE XIII

DECISION MATRIX FOR DBPH AUDIO PRODUCTS AND SERVICES

QUALITY FACTORS

	All record player system (books on hard records, magazines on flexible discs)	All cassette player system (15/16 ips, 4-trk) (books on cassettes, magazines on short cassettes)	All cassette player system (1 7/8 ips, 2-trk) (books on cassettes, magazines on short cassettes)	Basic cassette player system (15/16 ips, 4-trk) with accessory disc unit (books on cassettes, magazines on flexible discs)	Basic cassette player system (1 7/8 ips, 2-trk) with accessory disc unit (books on cassettes, magazines on flexible discs)	Comparative Orders of Importance
Machine Breakdown Rate	Good except high needle replacement	Good	Good	Good without accessory disc unit Fair with accessory disc unit	Good without accessory disc unit Fair with accessory disc unit	8
Convenience (Portability, ease of loading, ease of use outside the home)	Poor	Excellent	Excellent	Excellent with cassettes Poor with discs	Excellent with cassettes Poor with discs	7
User Acceptance (versatility in field, modernity)	Fair	Good	Good	Good	Good	4
Quality of Sound	Good	Good	Good	Good	Good	5

Operational Problems or Risks	Few	Some possibility of technical problems initially	Few	Some possibility of technical problems initially	Few	6
Ease of Duplication of Media in the Field	Not Possible	Excellent	Excellent	Excellent for cassettes Not possible for discs	Excellent for cassettes Not possible for discs	4
Storage and Shelving of Media for Libraries	Fair	Good	Fair	Good	Fair	3
Wearing of Media	Good	Excellent	Excellent	Excellent for cassettes Fair for discs	Excellent for cassettes Fair for discs	5
Possibility of Reuse of Media	Not Possible	Good	Good	Good for cassettes Not possible for discs	Good for cassettes Not possible for discs	2

machine breakdown rate with an importance rating of 8 is considered to be about twice as important as user acceptance with a rating of 4.

Tables XII and XIII thus constitute a two part decision matrix presenting in summary form the most important data on the evaluation of the five most probable alternative systems. This decision matrix can be used to evaluate and compare the most important facets of different alternative systems. Used in conjunction with the order of importance indicators such comparisons can lead to an overall evaluation of different alternative systems.

After a review of cost and quality factors which have been presented in the foregoing discussion, and the consideration of all important elements including the objective DBPH is attempting to achieve, it is our conclusion that DBPH should adopt the 4-Track, 15/16 ips C90 cassette format for its circulating book requirements in the future. Associated with this step, there will be the appropriate production of cassette players. For magazine distribution we favor the continuation of the flexible disc to be used in a "direct circulation" mode only.

The levels of media and machine production required to follow out the Q.E.I. plan are detailed together with projected costs for the period thru 1980 in Tables XIV and XV. Table XIV provides our summary of the estimates of machines required and the book titles proposed for the period 1976 thru 1980. Table XV is a summary of the associated production costs projected from 1976 thru 1980.

TABLE XIV

PLAN PROPOSED BY Q.E.I. TO SUPPLY PLAYBACK MACHINES AND MEDIA FOR DBPH AUDIO SERVICES*

Year	Number of Cassette Players to be Provided	Number of Accessory Disc Units to be Provided	Number of Book Titles to be Provided (New Titles Plus Reissues)
1976	75,000	50,000	1,750
1977	75,000	75,000	1,750
1978	100,000	50,000	1,500
1979	100,000	50,000	1,500
1980	75,000	50,000	2,000

*Issuance of Magazines shall continue but by "direct circulation" only.

TABLE XV

EXPECTED COSTS OF THE PLAN PROPOSED BY Q.E.I. FOR PLAYBACK MACHINES AND BOOKS*

Year	Expected Total Costs of New Cassette Players	Expected Total Costs of New Accessory Disc Units	Expected Total Costs of Cassette Books	Expected Total Costs of DBPH Magazines
1976	$4,580,000	$1,400,000	$4,250,000	$1,460,000
1977	$4,820,000	$2,230,000	$4,500,000	$1,650,000
1978	$6,750,000	$1,580,000	$5,750,000	$1,840,000
1979	$7,080,000	$1,670,000	$6,090,000	$2,080,000
1980	$5,560,000	$1,775,000	$8,620,000	$2,300,000

*This assumes that in 1976 and 1977, 300 copies of each of 750 book titles already available on hard records will be reissued on cassettes, along with an average of 1000 copies of 1000 titles. In 1978 and 1979, it is assumed that an average of 1000 copies of each of 1500 titles will be issued on cassettes; while in 1980, an average of 1000 copies of 2000 titles will be issued. It is also assumed that all books will be issued on 4-Track, 15/16 ips C90 cassettes from 1976-80. It is also assumed that all magazines will be issued on flexible discs, with cost per disc being prorated to take account of differences in sizes of issues.

J. RECOMMENDATIONS AND SUGGESTED ITEMS FOR FOLLOW-UP

We offer the following recommendations to DBPH for consideration in its current planning for audio services:

1. In the period which includes 5 to 10 years into the future, DBPH adopt the use of cassettes only for its circulating book materials. For magazines and large edition news material, DBPH continue the use of flexible discs, but only on a "direct circulation" basis. (See discussion above, pp. 35-38).
2. DBPH plan at once the phase-out of records over a 10-year period. Continue Talking Book records circulation and Talking Book Machine maintenance only as required to meet needs of present Talking Book Machine users. (See pp. 35-38).
3. DBPH continue with issuance of Talking Book records and machines as planned for the current fiscal year but plan on no production after FY75. (See pp. 35-38).
4. DBPH adopt 4-Track, 15/16 ips cassettes as the standard format for future Talking Book circulating materials. (See pp. 38-39).
5. DBPH adopt a cassette player design capable of giving acceptable quality for a 4-Track cassette with speed of 15/16 ips as the continuing basic standard player for Talking Books. Provide 1 7/8 ips speed as well as the 15/16 ips capability on the basic machine. Make provision that this machine shall be designed to provide the audio circuitry and controls for an accessory disc

turntable unit which is to be made available for all users of flexible discs. (See pp. 50-52).

6. Take all possible steps to expedite the issuance of more cassette playback machines as soon as possible in order to meet the current backlog and the anticipated increased demand. Attempt to achieve production of a least 50,000 machines in FY75, 75,000 in FY76, 75,000 in FY77, 100,000 in FY78, 100,000 in FY79, 75,000 in FY80. (See pp. 71-73).

7. Increase the number of cassette book titles issued to a level of 1750 per year in FY76 and FY77 by issuing 1000 new titles and 750 reissues from record masters per year. Plan for production of at least 1500 new titles per year in FY78 and FY79 and 2000 titles per year thereafter. (See pp. 71-73).

8. Plan for and initiate the immediate production of a disc turntable unit capable of being used as an accessory to the basic cassette playback unit. Plan for production of 50,000 units in FY76, 75,000 units in FY77, 50,000 units in FY78, 50,000 units in FY79 and 50,000 units in FY80. (See pp. 71-73).

9. Initiate a more intensive program of quality control on media and machines produced for the DBPH. To make this possible and to do more testing and development to set more specific design standards, expand the staff of the DBPH technical division.

10. Initiate changes in current planning to put the above recommendations into effect and request additional funding to make the program possible.

We suggest that the following items be given further attention and follow-up:

1. Take steps to see that more detailed and specific information and statistics are generated about user needs and interests. Set up a mechanism to acquire user feedback about program plans and changes.
2. Arrange for more formal inventory and status control over loaned equipment.
3. Attempt to supply procedures and materials to make possible the generation of more specific information regarding Talking Book usage, as well as circulation and distribution problems and needs.
4. Promote means, particularly with volunteer assistance, to see that direct personal instruction is given to users in connection with the introduction or modification of any equipment.
5. Conduct a thorough human factors study of media usage and equipment operation and incorporate the findings of this effort into future equipment designs.
6. Effect improvements in the instructions, and usage manuals for media and equipment used by blind and handicapped persons.
7. DBPH provide capabilities at its headquarters facility to assist any network participant to convert its duplicating equipment because of the change to the 4-Track cassette format.
8. Determine if there is any procedural or operational

cost advantage if books to be produced for DBPH are separated into "short book" (12 hours or less), or "long book" (over 12 hours) categories. (See pp. 40-45).

9. Initiate a study to determine projected costs of FM sub-carrier or Cable distribution for future DBPH operations. (See pp. 54-55).

10. Take steps to initiate an informational program to see that all possible eligible users are aware of the DBPH audio services.

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10. Consumer Reports, May, 1971, "Cassette Tape Recorders", pp. 279-283

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APPENDIX I

LIST OF CONTACTS

Personal Contacts

Mrs. Gisela M. Titman, Librarian
Massachusetts Regional Library
for the Blind and Physically Handicapped
Perkins School for the Blind
Watertown, Massachusetts

Mr. Kenneth Stucci
Perkins School for the Blind
Watertown, Massachusetts

Mrs. Diane Kester, Chief of Services for the Blind
California State Library
Sacramento, California

Mr. A. Jenkins, Orientation Center for the Blind,
Division of California Rehabilitation Service
Albany, California

Mr. S. Augustino, Technical Assistant
Services for the Blind
San Francisco Public Library
San Francisco, California

Mr. C. W. Helmstetter, National Sales Manager
Ampex Corporation
Redwood City, California

Telephone and Mail Contacts

Mr. Robert P. Stewart, Librarian
New York State Library
Library for the Blind
Albany, New York

Mrs. Barbara L. Wilson, Librarian
Rhode Island Regional Library
for the Blind and Physically Handicapped
Rhode Island Department of State Library Services
Providence, Rhode Island

Mr. Michael P. Coyle, Librarian
Library for the Blind and Physically Handicapped
Philadelphia, Pennsylvania

Eileen Keim, Librarian
New Hampshire State Library
Library Service to the Handicapped
Concord, New Hampshire

Mary E. Tincovich, Librarian
Library for the Blind and Physically Handicapped
Connecticut State Library
Hartford, Connecticut

Mrs. Florence Grannis, Librarian
Library
Iowa State Commission for the Blind
Des Moines, Iowa

Mr. Kenneth Jernigan, President
National Federation of the Blind
Des Moines, Iowa

Mrs. Martha Hahnel
National Association of the Physically
Handicapped
Cincinnati, Ohio

Mr. Durwood McDaniel
American Council of the Blind
Washington, D.C.

Mr. Leslie L. Clark, Director
International Research Information Service
American Foundation for the Blind, Inc.
New York, New York

Dr. and Mrs. Thomas Benham
Science for the Blind
Balla Cynwyd, Pennsylvania

Mr. Glenn Scheurich, Head
Talking Book Department
American Printing House for the Blind
Louisville, Kentucky

Mr. Lawrence Johnson
Evatone Company
Deerfield, Illinois

Mr. William Ganter, Sales Representative
3M Company
Needham, Massachusetts

NOTE: In most cases discussion with the above contacts led to a substantive exchange of information; however, in a few cases, little information was obtained.

MEMBERS OF THE STAFF OF DBPH
WITH WHOM WE HAD PERSONAL CONTACT

Mr. F. K. Cylke

Mr. C. Gallozzi

Mr. R. Garretson

Mr. J. Kozar

Mr. R. Evenson

Ms. M. Werner

Mr. W. West

Mr. S. Herman

Ms. H. Kamisar

MEMBERS OF THE TECHNICAL STAFF AND CONSULTANTS OF Q.E.I., INCORPORATED, BEDFORD, MASSACHUSETTS

APPENDIX II

DBPH ELIGIBILITY STATISTICS 1973/1974

SUMMARY

Certain Eligibility

Severe visual impairment	1,306,000
Absence of one or both arms or hands	81,000
Cerebral palsy (paralyzed)	181,000
Muscular dystrophy (completely disabled)	50,000
Quadriplegia	51,000
Hemiplegia	199,000
	1,868,000

Possible Eligibility

Arthritis or rheumatism	857,000
Cerebral palsy (excluding those paralyzed)	569,000
Huntington's disease	14,000
Learning disabilities	1,542,000-2,570,000
Mental retardation	1,525,000-6,100,000
Multiple sclerosis and related diseases	500,000
Muscular dystrophy (excluding those completely disabled)	150,000
Myasthenia gravis	30,000
Paraplegia	102,000
Parkinson's disease	200,000
Spina bifida	27,500
Spinal cord injury	125,000
Tumors of the brain and nervous system	140,000
	5,781,500-11,384,500

Age by Eligibility

47.2% of the legally blind are 65 and over. (NSPB, 1962)

69.6% of the severely visually impaired are 65 and over. (NCHS, 1971)

49.7% of paralyzed cerebral palsy victims are under 17. (NCHS, 1971)

About 2/3 of known muscular dystrophy victims are between the ages of 3 and 13. (MDA)

All figures quoted for the learning disabled are for children of elementary and secondary school age.

49.7% of hemiplegia victims are 65 and over. (NCHS, 1971)

APPENDIX III

LINEAR REGRESSION

Projections derived from linear regression analysis employ the formula $y = bx + a$ to predict values of the dependent variable y (in this case, number of users) from given values of the independent variable x (here, years). b and a are constants which are determined from a given set of values of x and y. This determination can be likened to the passing of a straight line through a group of points on a graph with given coordinates (x,y) in such a manner that the sum of the squares of the differences between the values of the given points and the values of points on the line is minimized. The linear regression line in some sense represents the group of points better than any other straight line. When predictions are made using linear regression analysis, some error in the prediction is inevitable. The maximum size of this error for each x is indicated by the corresponding figure in the error column. These errors were calculated for the 90% confidence level, which means that in 90% of the cases, the true errors are indeed less than the maximum given errors. See Walpole, Ronald, Introduction to Statistics, Macmillan, New York, 1968 for further discussion of regression analysis.